

Statement of Dr. April Brown
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before the
Subcommittee on Science, Technology, and Space
Committee on Commerce, Science and Transportation
United States Senate
October 3, 2002

Senator Wyden, members of the Subcommittee on Science, Technology and Space, and congressional staff, I am pleased and honored to have the opportunity to share my perspective with you today on how we can take important steps to remove a formidable threat to our future: the declining number of engineers and scientists. Our opportunity today is to consider how we can apply an existing law, Title IX of the Education Amendments of 1972, to increase the number of women engineers and scientists.

This panel has already heard compelling testimony that describes how the shrinking pool of scientists threatens our national security, including a citation of the Hart-Rudman Commission on National Security to 2025, which warned that America's failure to invest in science and to reform math and science education was the second biggest threat to our national security; and NASA Administrator Sean O'Keefe's revelation that NASA's current over-60 workforce is three times larger than its under-30 workforce.

I know you are well aware of the barriers to success women and girls face in scientific and technological careers from your previous work on this Committee, so I will focus today on the opportunity provided by Title IX to eliminate them.

Though its most visible success has been in athletics, Title IX is an education law, not a sports law. Universities and governmental funding agencies can apply Title IX toward bringing more women into careers in science and engineering. The resulting pool of scientists and engineers will be larger and more diverse, which means we as a nation will be better prepared for the technological challenges our future will bring.

I am a professor in the field of electrical and computer engineering. Like many other women engineers, I considered engineering as a career because I had an engineer -- my father -- in the family. We must reach a point in this country where we do not have to rely on family members to interest girls in engineering, and where we are committed as a society to the participation of girls and women in engineering. We must develop role models -- successful and visible women engineers in academia, industry, and the government. Role models show young women that they, too, can do it! Role models are especially critical at educational transitions from high school to college and then on to graduate school. It is during these transitions that we lose many women on the journey to full and successful careers in engineering and science.

Reasons why we lose many would-be engineers include inadequate math and science preparation in K-12 education, the poor public understanding of engineering, and the traditional delivery of engineering education, but my specific focus is on the success of women engineers in the academy. They are the role models and shapers of education and research. Their experience starts in graduate school -- the initial training ground of our future professoriate.

We must increase the number of women faculty members in science and engineering to increase the number of women engineers and scientists in the workforce. Less than 10% of engineering faculty members are women. My field, electrical and computer engineering, is the most rapidly growing engineering discipline. Yet in ECE, only 7% of the professoriate are women. Even the engineering programs with the highest percentages of female faculty in the country have less than 30% women.

Women science and engineering faculty members are necessary for an excellent engineering education. William Wulf, president of the National Academy of Engineering, identified diversity as a key imperative for an agenda for change in his article "A Makeover for Engineering Education," in the journal *Issues in Science and Technology*, Spring 2002. He states, "Our creative field is deprived of a broad spectrum of life experiences that bear directly on good engineering design." He's saying that engineering is about solving problems, and the more viewpoints that examine a problem, the better the chances of solving it. The undergraduate and graduate educational experience shapes our future engineers and scientists. A *diverse* faculty offers a much richer educational and research experience to these students.

Women students are drawn to women faculty and seek them out. Studies have shown that women faculty members are the primary research advisors to a larger number of female students than men (Mary Frank Fox, in *Equal Rites, Unequal Outcomes: Women in American Research Universities*, edited by L. Hornig. New York: Kluwer Academic/Plenum Publishers, 2002). Many women are lost along the way if they cannot identify and relate to a teacher for guidance toward a successful career. My own experience bears this out. I joined a graduate research group at Cornell University led by Professor Lester Eastman, who actively sought out female students -- a rare occurrence at the time. I worked most closely with other women in my group. When I took my place on the faculty at the Georgia Institute of Technology in 1994, female students sought me out. My first two Ph.D. students were women: Dr. Carrie Carter-Comen and Dr. Georgiana Dagnall.

Understanding the Barriers to Women Scientists and Engineers in the Academy

Women graduate students and engineers in the professoriate have different experiences from men. The MIT Study on the Status of Women in Sciences made headlines in 1999 when the university unveiled its self-assessment showing that women received a smaller share of important resources: space, start-up research funding, etc. in comparison to men. In 1998, I co-chaired the Task Force on Opportunities for Women in Engineering at Georgia Tech that showed that women are significantly concerned about the balance of work and family. Just last week, the University of Michigan unveiled its climate study on women faculty in science and engineering.

Studies have shown that women have less access to important resources than men. Women report fewer mentors than men. Women have fewer graduate students than men. Women serve on more committees than men, yet they do not chair committees as often as men.

Research done by Mary Frank Fox, a sociologist at Georgia Tech, shows that engineers and scientists must be part of social networks for success in their fields. Developing collaborations, attracting the best graduate students to their laboratories, receiving guidance through mentors, and being asked to serve on important conference committees are critical to career success and happen through social interactions. The environment is created by the interplay of social processes and organizational policies and practices, such as ways in which people are evaluated and rewarded. They cannot be separated from each other.

Professor Virginia Valian, a psychologist at Hunter College, shows in her recent book *Why So Slow: the Advancement of Women* that despite general gains we have made in understanding the personal and social ills created by discrimination, day-to-day decisions that impact people are often unconsciously made on the basis of generalizations, or schemas. These schemas, still supported by media images, tell us that engineering remains a "masculine" profession, and women are less likely than men to attain success in science and engineering. Women find themselves disadvantaged by the cumulative effects of a succession of decisions based on these schemas that place more resources in the hands of their male colleague down the hall.

Organizational practices and policies are just as critical. One example is the tenure and promotion process that faces all tenure-track faculty members. For most of us, tenure is more about continuing on in our positions, than about a lifetime job guarantee. Tenure is granted to the successful faculty member by an in-depth evaluation of his or her research and educational contributions by peer faculty committees. Gender

schemas obviously come into play in this process. Tenure decisions are made approximately seven years after entry into the professoriate at the assistant professor rank. The model for evaluation assumes a trajectory for career success after attaining the Ph.D. that does not take into account that this is also the prime time for having children and starting families. Research by Dean Sue Rosser at Georgia Tech (*Journal of Women and Minorities in Science and Engineering*, vol. 8, pp. 163-191, 2002) shows that balancing a career and family is, in fact, the most significant challenge facing women engineers and scientists today.

I was personally quite taken by the real impact the timing of tenure and promotion has on people when I moved from industry to the academy. I had my first child after earning my Ph.D. and while working at Hughes Research Laboratories. When I joined Georgia Tech one year later as an associate professor, I learned that many women feel they must forgo childbirth and rearing until after tenure. Since tenure often is awarded in a person's early to mid-thirties, peak fertility is bypassed. This is an incredible disincentive to women in the academy.

How can we use Title IX to help

Title IX's regulations require institutions that receive federal funding to provide equitable athletic opportunities for all students, regardless of sex, in three separate areas: participation, treatment of athletes, and athletic scholarships. But Title IX does not just apply to athletics. The law states that "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any educational program or activity receiving federal financial assistance."

During the past 30 years, Title IX has created tremendous changes in athletics. Now is the time to use its power for engineering and sciences, with the hope that the results will be as dramatic.

Universities must comply with Title IX to receive federal funding. The government can and should do more to ensure compliance in the specific area of educational opportunities for women in science and engineering.

First, since graduate programs across the nation are the primary training ground for the professoriate of the future, universities could be required under Title IX to create more institutional graduate support (scholarships) for women graduate students. Successful recruiting and retention of women in graduate school creates the new faculty members we need to attract more women undergraduates to science and engineering.

Second, engineering programs can and should do more to ensure that their female faculty members -- and students -- have an equitable share of the resources provided by the institution. Title IX can be used to ensure that both financial aid and research support are equitably distributed among graduate students.

Third, university leaders must be accountable for the work environment they steward. They can be held accountable under Title IX's provision of continuous improvement of the environment for women, and there are many approaches for doing that for both students and faculty members. For faculty, these include better work-family policies, including tenure clock extensions. For students, these include supporting mentoring opportunities, such as Women in Engineering programs.

Federal funding is critical to science and engineering, and we must ensure that women principal investigators are well represented in funding agencies' research and education portfolios. The NSF has been proactive in its goal to support more women scientists and engineers through specific programs. One such program, ADVANCE, supports not only individual women, but activities that lead to institutional change. This program may prove to be a model for the type of organizational change we need in the academy.

Conclusion

Dedicated leadership clearly leads to great positive change. One reason for my move from Georgia Tech to Duke University was the representation of women leaders in the highest positions at Duke: Dean Kristina Johnson at the Pratt School of Engineering and President Nan Keohane. President Keohane has spearheaded a campus-wide initiative on the status of women at Duke. Through Dean Johnson's leadership, more than half of the faculty members hired in the Pratt School this past year are women. The growth of women faculty members in the Pratt School will profoundly affect the environment for women faculty members and students alike.

As the mother of two boys that I hope will someday consider becoming engineers, I fully believe that these changes will benefit them as well as their female friends.